

Chart of Nuclides, Nuclear Data in Nucleonica



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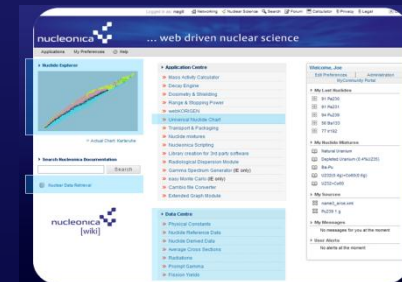


Chart of Nuclides, Nuclear Data in Nucleonica

Overview

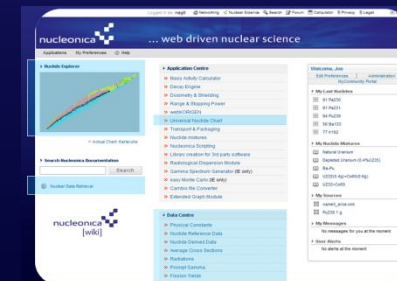
Nuclide Charts

Decay and Reaction Processes on the Nuclide Chart

Karlsruhe Nuclide Chart

Gamma Emission and Isomeric Transitions

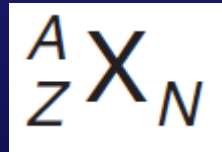
Use of Nucleonica for Gamma Emission Data



What is a nuclide?

A species of atom, characterized by its mass number A , atomic number Z and nuclear energy state (m or g), provided that the mean life in that state is long enough to be observable (IUPAC)

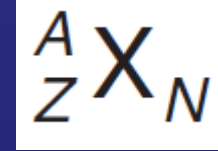
In general, an atom with atomic number Z , and neutron number N is known as a nuclide. A nuclide can be specified by the notation:



where Z is the atomic (proton) number, N is the neutron number, A is the mass number ($A=N+Z$), and X is the chemical element symbol.

Approximately 3000 nuclides are known, but only about 10% of these are stable. Nuclides with the same N and different Z are called isotones, and nuclides with the same mass number A are known as isobars.

What is a nuclide?

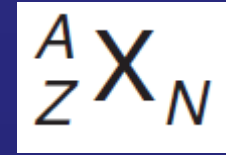


Because of the relationships between Z , A , N ($A = Z + N$) and X , a nuclide can be uniquely specified by fewer parameters. A particular chemical element is uniquely specified by its symbol X or the proton number Z . A nuclide is uniquely specified by the element name X (or proton number Z) together with the mass number A .

An example is ^{60}Co which refers to the element cobalt (chemical symbol Co) with mass number 60 (number of protons plus neutrons). A variety of ways of referring to this nuclide are in current use i.e. $\text{Co}60$, $\text{Co-}60$, $\text{Co } 60$, ^{60}Co , and cobalt-60.



What is a nuclide?



Nuclide: Refers to a particular atom or nucleus with a specific number N of neutrons and number Z of protons. A is the mass number ($= Z + N$). Nuclides are either stable or radioactive. Radioactive nuclides are referred to as radionuclides.

Atomic Number, Z : The number of positively charged protons in the nucleus of an atom.

Neutron Number, N : The number of neutrons in the nucleus of an atom.

Isotope: One of two or more atoms of the same element that have the same number of protons (isotope) in their nucleus but different numbers of neutrons. Radioactive isotopes are referred to as radioisotopes.

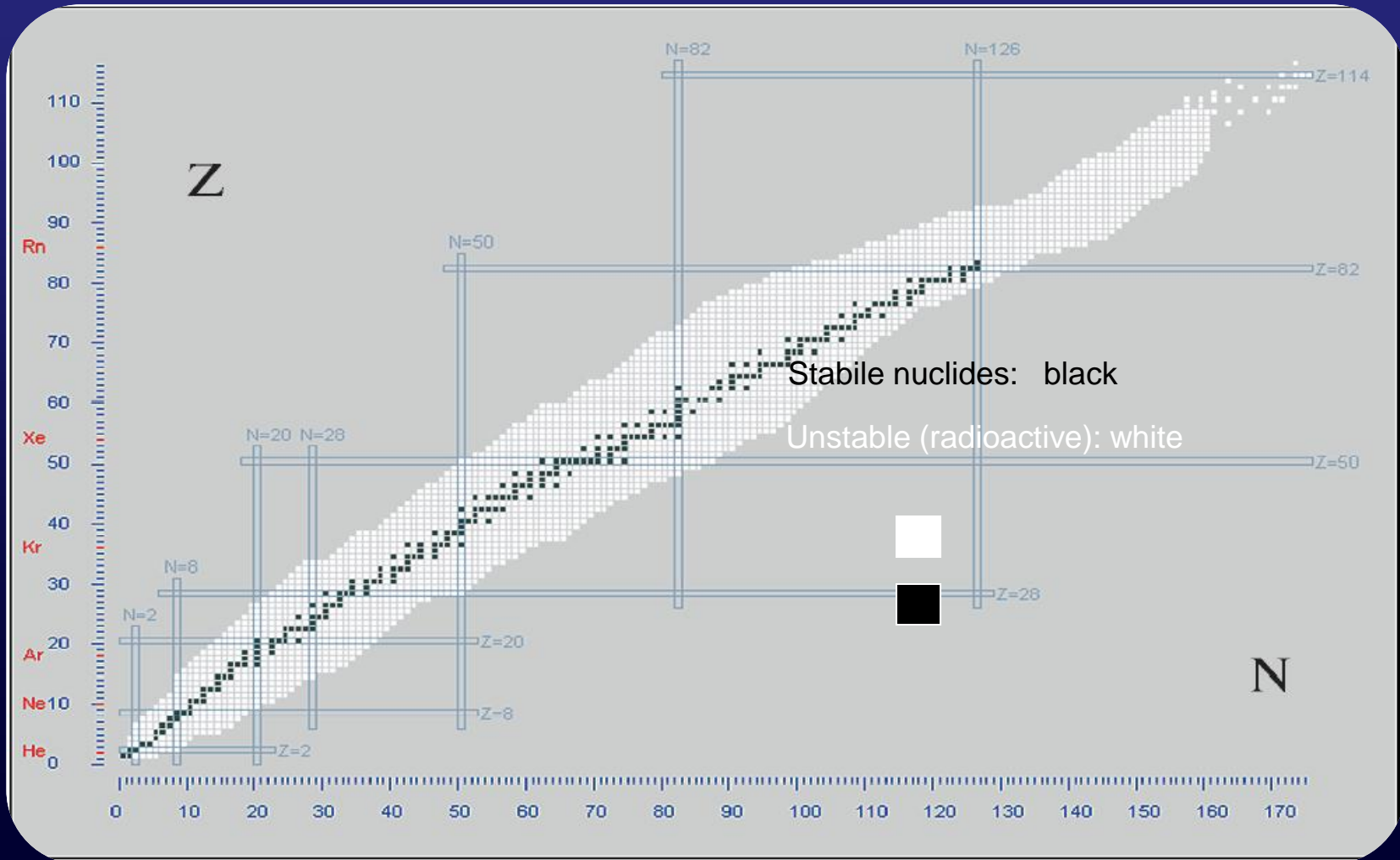
Isotone: One of several different nuclides having the same number of neutrons (isotone) in their nuclei.

Isobar: Nuclides with the same atomic mass number $A (= Z + N)$ but with different values of N and Z e.g. ^{14}B , ^{14}C , ^{14}N .

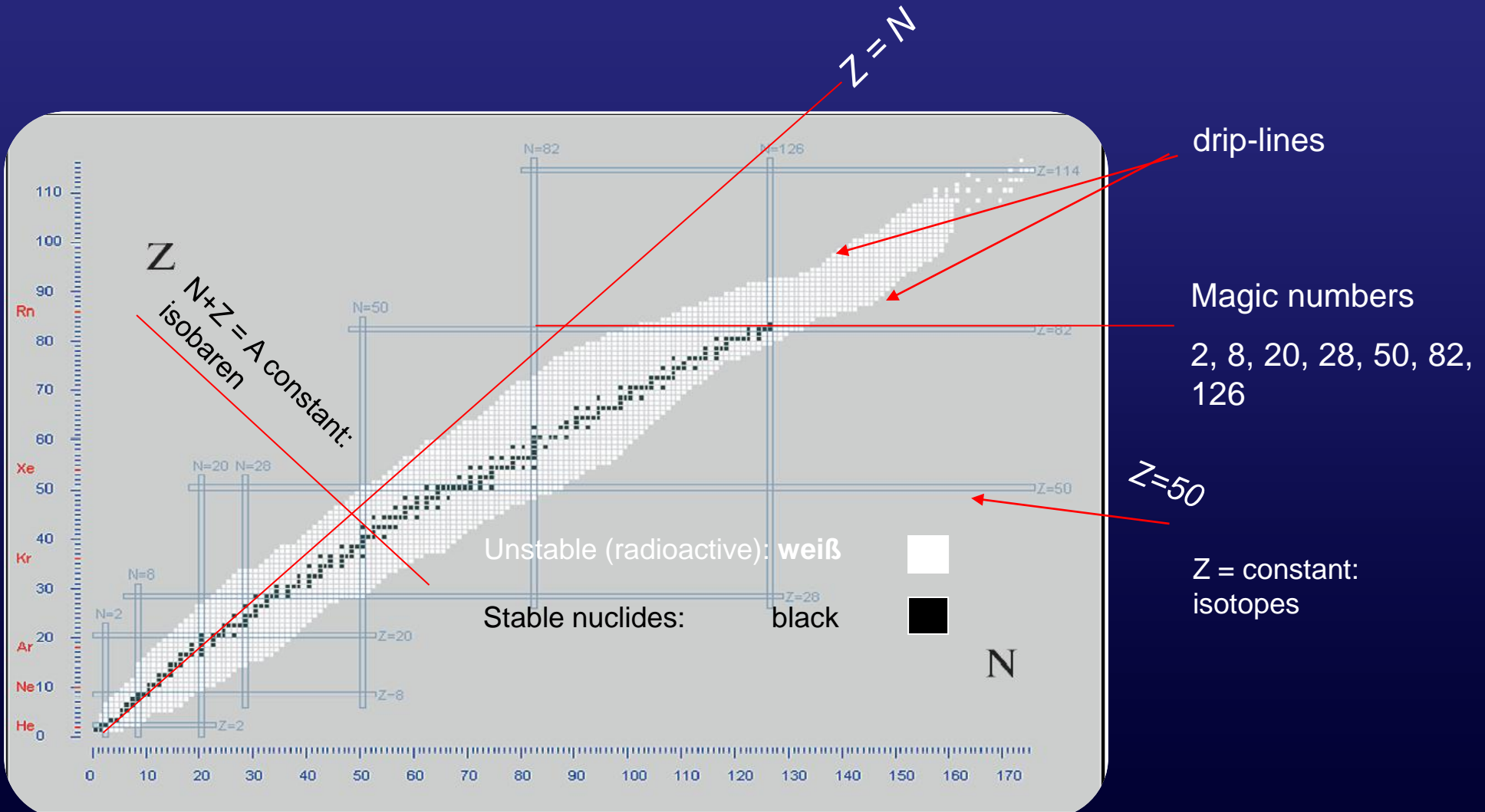
Isomer: Atoms with the same atomic number Z and the same mass number A in different long-lived states of excitation – the higher states being metastable with respect to the ground state. For example, an isomer of ^{99}Tc is $^{99\text{m}}\text{Tc}$ where the m denotes the long-lived excited state.

What is a Nuclide Chart?

What is a nuclide? A species of atom, characterized by its mass number, atomic number and nuclear energy state, provided that the mean life in that state is long enough to be observable.



What is a Nuclide Chart?



Karlsruhe Nuclide Chart ...

It all started with the Karlsruhe Nuclide Chart ...



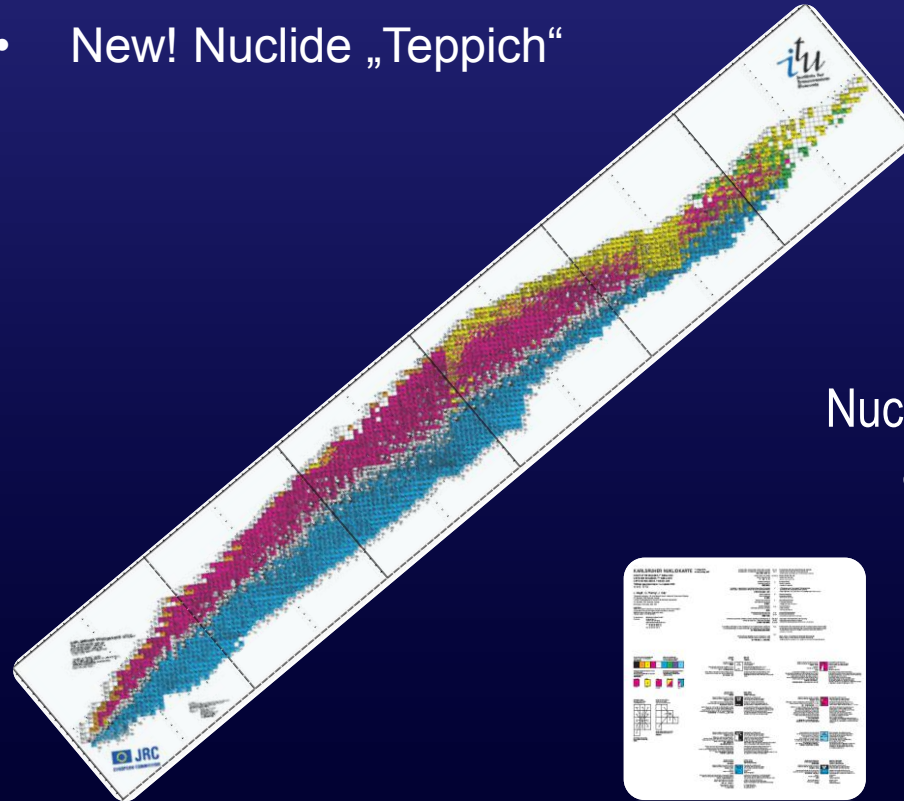
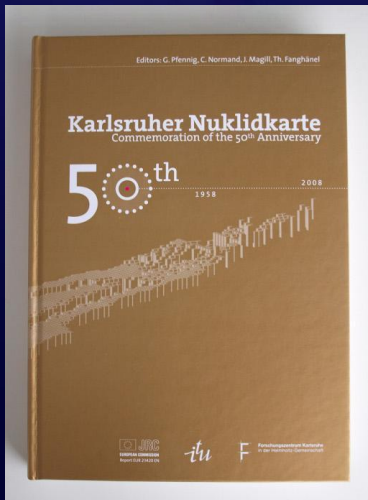
<http://www.KarlsruheNuclideChart.net>

Karlsruher Nuklidkarte ...

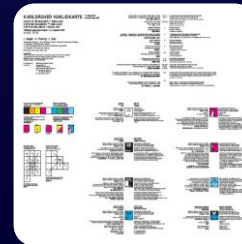
- New! 2009 Druck der Broschüre + Faltkarte
- New! 2010 Druck der Wandkarte
- New! Nuclide „Teppich“



2008



Nuclide „carpet“
8m!



Explanation of the Karlsruhe Chart of Nuclides

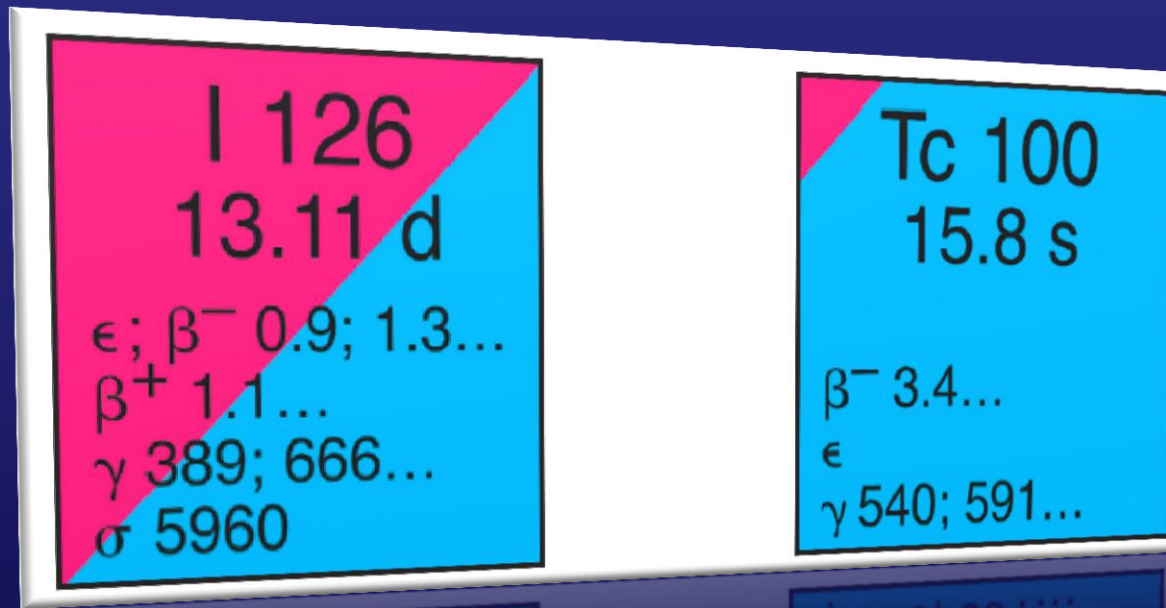
Use of Colours in the Nuclide Chart :

The Karlsruhe Chart of the Nuclides showing the colours used to indicate the decay modes:

- black = stable nuclide
- yellow = α -decay
- red = β^+ -decay or electron capture;
- blue = β^- -decay;
- white = isomeric transition).

Bi 207 31.55 a ϵ β^+ ... γ 570; 1064; 1770...	Bi 208 $3.68 \cdot 10^5$ a ϵ γ 2615	Bi 209 100 $1.9 \cdot 10^{19}$ a α 3.137 σ 0.011 + 0.023 $\sigma_{n,\alpha} < 3E-7$
Pb 206 24.1 σ 0.027	Pb 207 22.1 σ 0.61	Pb 208 52.4 σ 0.00023 $\sigma_{n,\alpha} < 8E-6$
Tl 205 70.48 σ 0.11	Tl 206 3.7 m 4.20 m I_γ 686; 453; 216; 256; 1021... β^- 1.5... γ (803...)	Tl 207 1.33 s 4.77 m I_γ 1000; 351 β^- 1.4... γ (898...)

Multiple Decay Modes and Branching Ratios

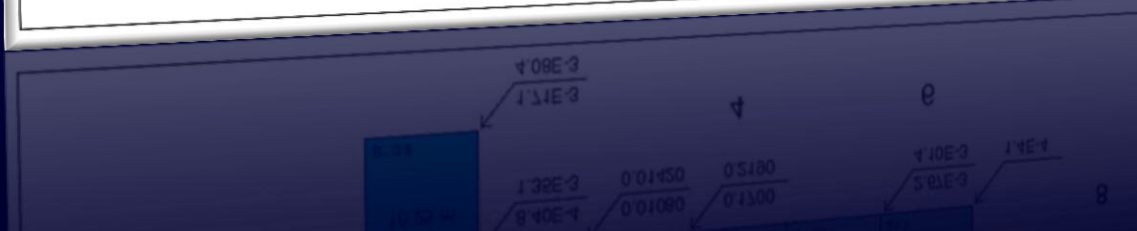
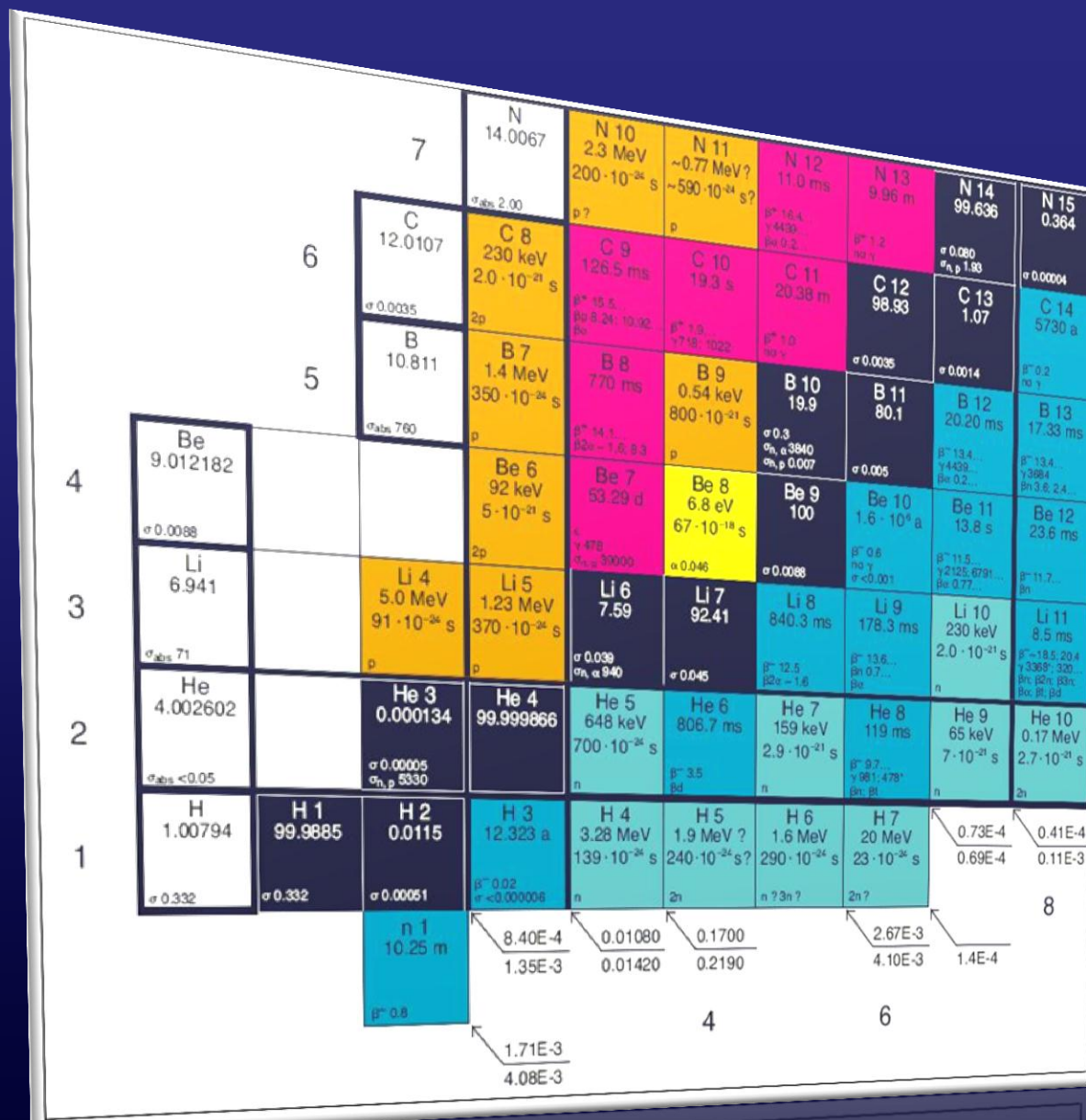


When a nuclide has more than one mode of decay, the use of coloured triangles gives an indication of the branching ratios of the different decay modes.

Left: The large triangles in I-126 indicate that the branching ratios for electron capture and beta emission are $\geq 5\%$, but $\leq 95\%$.

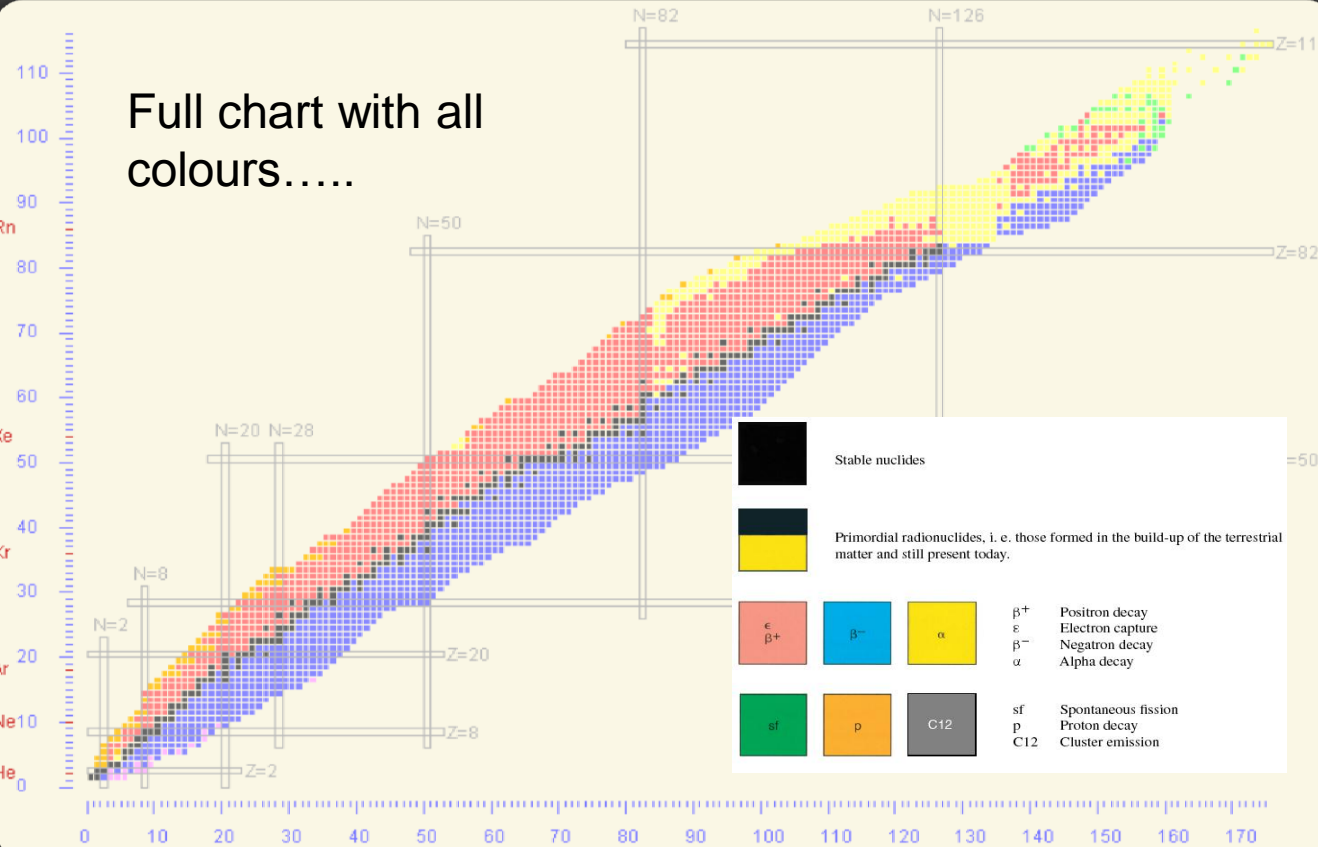
Notice that the order of the branching ratios in the text box indicates the most important, second most important etc.

Right: The small triangle in Tc-100 indicates that ϵ branching ratio $\leq 5\%$ is. The corresponding value for β^- emission $\geq 95\%$.



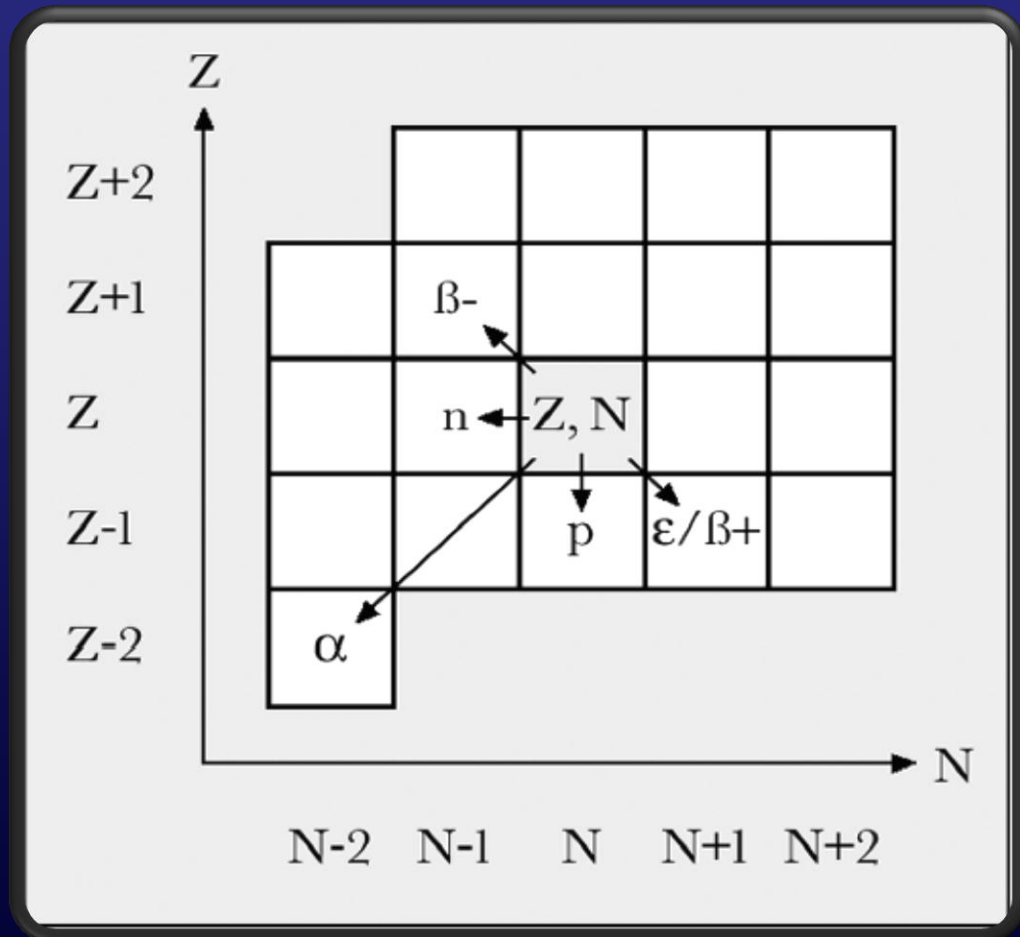
What do the colours mean?...

Full chart with all
colours.....



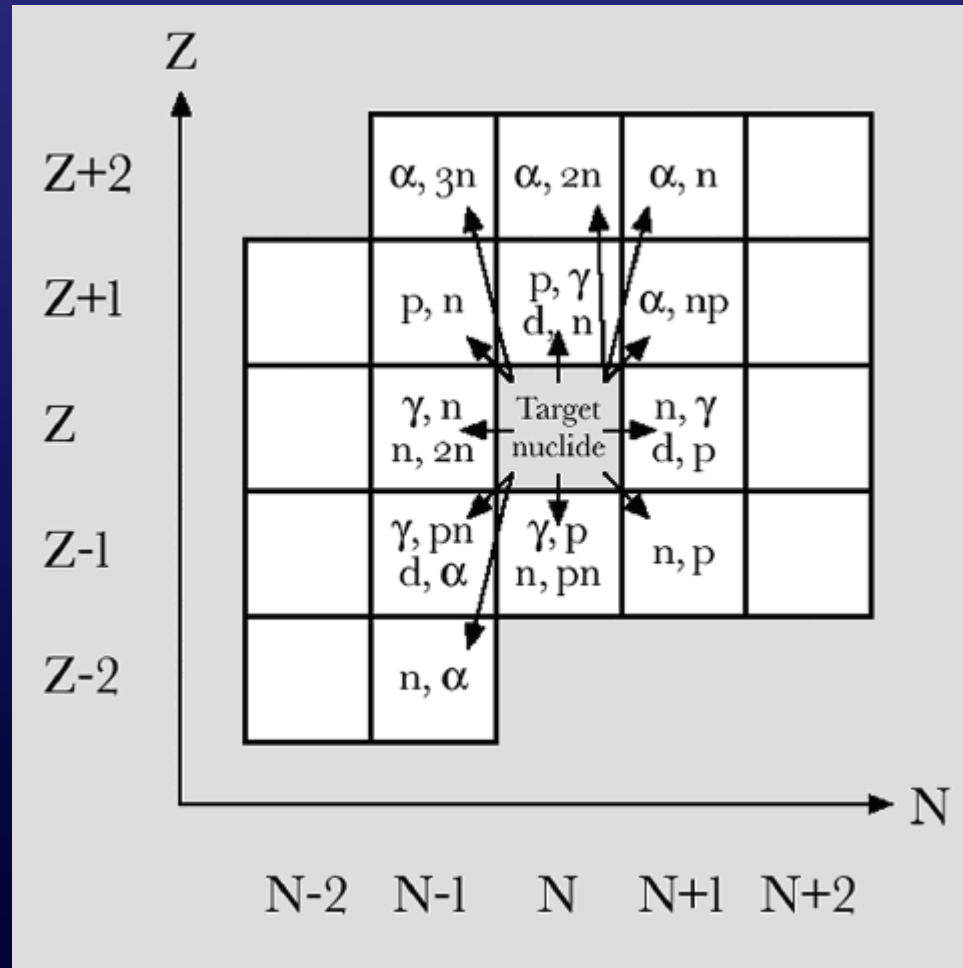
Radioactive Decay...

Nuclear decay processes on the nuclide chart. A nuclide with “co-ordinates” Z, N transforms to the nuclide Z', N' through the decay processes shown;

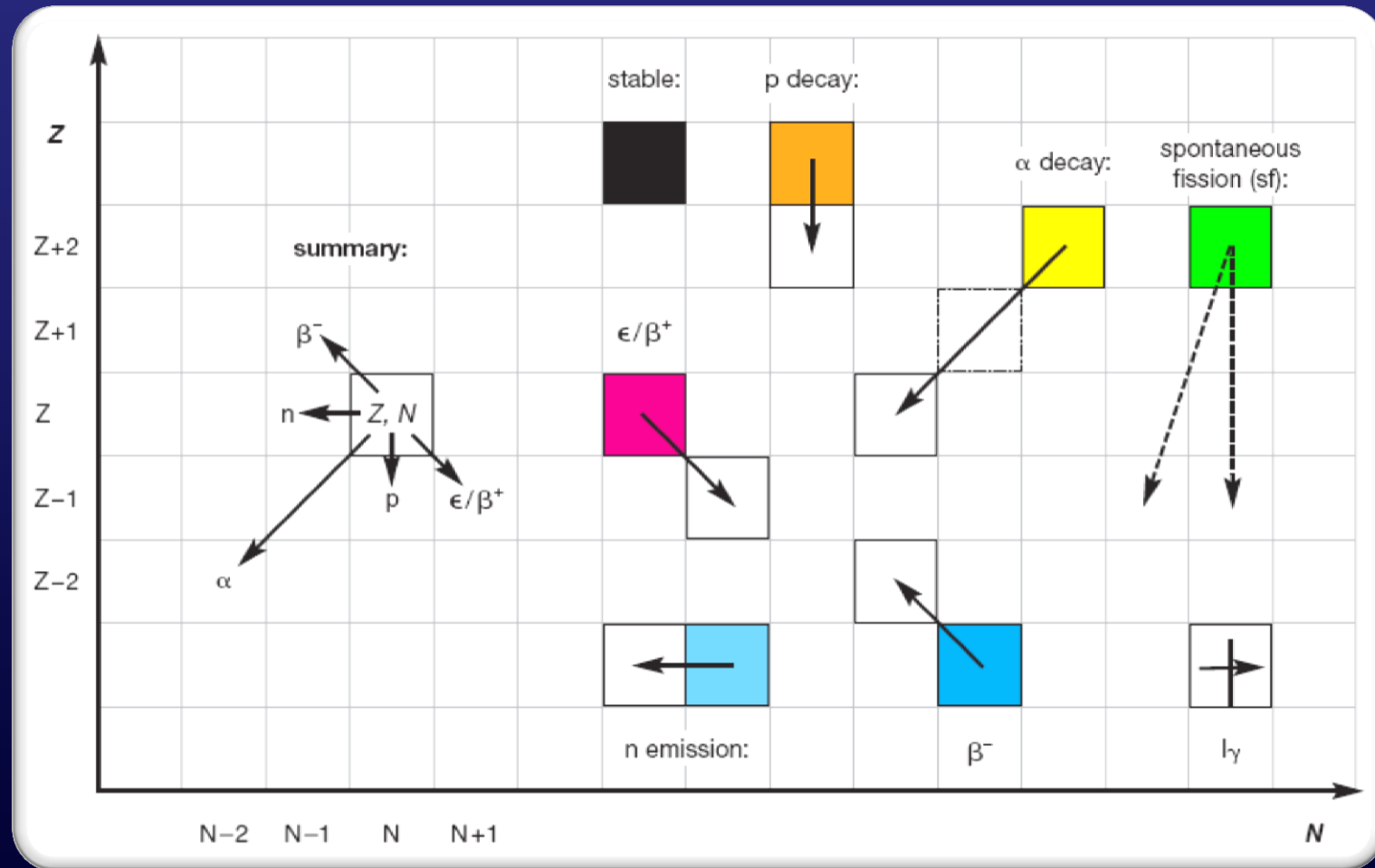


Activation Process and Nuclear Reactions...

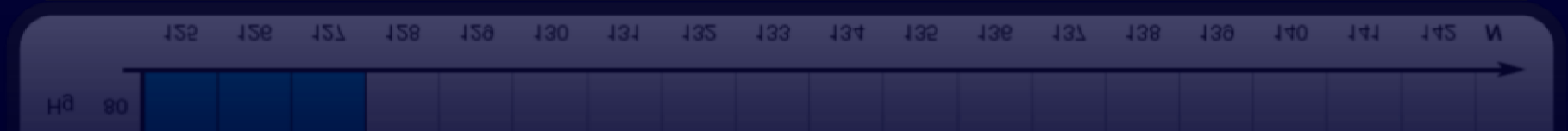
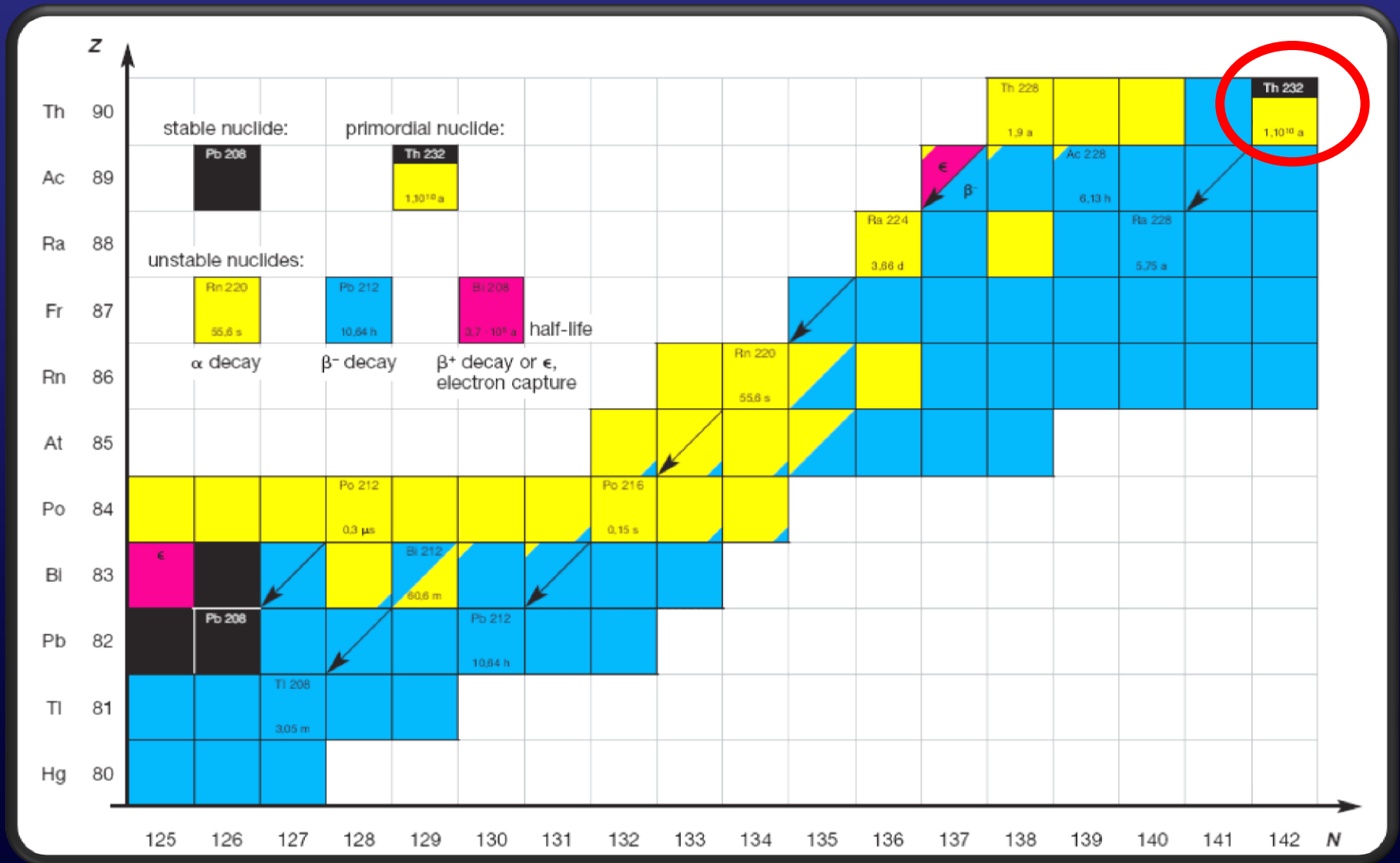
Activation processes and nuclear reactions on the nuclide chart. A target nuclide with co-ordinates Z, N transforms to the nuclide Z', N' through the processes shown



Radioactive Decay...

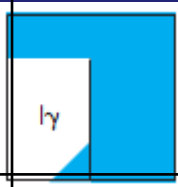


Karlsruhe Nuclide Chart: Th232 Decay



Gamma Emission and Isomeric Transition (I_γ)

Table 1: Notation used for gamma emission data in the Karlsruhe Nuclide Chart

The data given in the left part of the nuclide box apply to the metastable state, those in the right part to the ground state. I_γ denotes γ -quanta due to the decay to the ground state of the same nuclide (isomeric decay).	
Points indicate further transitions of the same type with lower intensities.	...
Energies are given in keV for γ -quanta, in MeV for all kinds of particles. A radiation symbol without energy value indicates that the radiation occurs but the energy has not been measured.	
Energies of the strongest γ -quanta arranged in order of decreasing intensities. Intensities less than 1% are given in brackets.	γ 815, 1711... γ (1340)
γ -Energies followed by an asterisk denote transitions after β -delayed particle emission.	γ 815*
Several γ -quanta of unknown intensities within the energy interval 291-1319 keV.	γ 291- 1319
Conversion electrons are specified only if they are more probable than the γ -quanta. Energies are not quoted.	e^-

Bi 207 31.55 a ϵ β^+ ... γ 570; 1064; 1770...	Bi 208 $3.68 \cdot 10^5$ a ϵ γ 2615	Bi 209 100 $1.9 \cdot 10^{19}$ a α 3.137 σ 0.011 + 0.023 $\sigma_n, \alpha < 3E-7$
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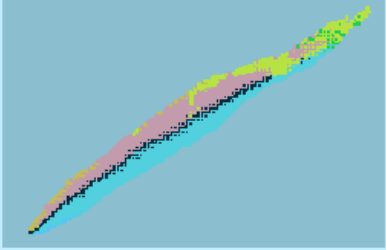
Where to find nuclear data in Nucleonica?

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» Actual Chart: Karlsruhe

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- 91 Pa230
- 91 Pa231
- 94 Pu239
- 56 Ba133
- 77 Ir192

► My Nuclide Mixtures

- Natural Uranium
- Depleted Uranium (0.4%U235)
- Ba-Pu
- U232(0.4g)+Co60(0.6g)
- U232+Co60

► My Sources

- name3_srce.xml
- Pu239 1 g

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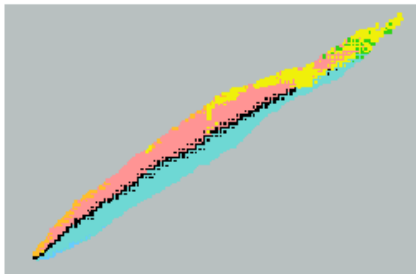
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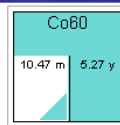


Application Centre

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Data Centre

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Nuclide Datasheets 27 Cobalt

Current Chart: Karlsruhe

Element: Mass:

Co 60

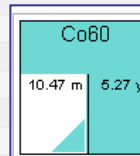
Reference Data Description Derived Data Cross Sections Radiations Prompt Gammas Select Print Outputs

Reference Data Notes

Density	8.86 g/cm ³
Mass Excess	-61649.012 (± 628) keV
Atomic Mass	59.933817059 (± 674) u
Half-life	5.271 (± 1) y
Spin	5 h
Parity	+
Binding Energy	
Abundance	
Effective Dose Coefficient Inhalation	
Effective Dose Coefficient Ingestion	
Mean Decay Energies	
Alpha	
Electron	
Photon	
Type of decay	
β-	
Type of parent decay	
IT	

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Nuclide Datasheets 27 Cobalt

Current Chart: Karlsruhe

Element: Mass:

Co 60

Reference Data Description Derived Data Cross Sections Radiations Prompt Gammas

Nucleonica

☐ Gamma Rays ☐ Beta Rays ☐ Discrete Electrons ☐ X-rays and Annihilation Radiation

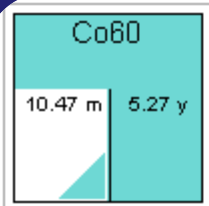
Update

No messages

User Alerts

No alerts at the moment

Nuclide Reference Data...



Nuclide Datasheets

27 Cobalt

Current Chart: Karlsruhe

Element: Mass:

Co 60

Reference Data Description Derived Data Cross Sections Radiations Prompt Gammas

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☒ Gamma Rays ☐ Beta Rays ☐ Discrete Electrons ☒ X-rays and Annihilation Radiation

Update

Element: Mass:
Co 60

Reference Data Description Derived Data Cross Sections Radiations Prompt Gammas Select Print Outputs

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☒ Gamma Rays ☐ Beta Rays ☐ Discrete Electrons ☒ X-rays and Annihilation Radiation

Update

Gamma Rays

Number of lines: 6

Sum E.P (eV per disintegration): 2.50E+06

Energy, E(keV)	ΔE (keV)	Emission Probability, E.P.	$\Delta E.P.$	Energy x Emission
1332.49	0.004	0.999826	6E-06	1.33E+03
1173.23	0.003	0.9985	0.0003	1.17E+03
826.1	0.03	7.6E-05	8E-06	6.28E-02
347.14	0.07	7.5E-05	4E-06	2.60E-02
2158.57	0.03	1.2E-05	2E-06	2.59E-02
2505.69	0.005	2E-08	4E-09	5.01E-05

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Graph

X-rays and Annihilation Radiation

Number of lines: 4

Sum E.P (eV per disintegration): 8.35E-01

Energy, E(keV)	ΔE (keV)	Emission Probability, E.P.	$\Delta E.P.$	Energy x Emission
7.47815	4E-05	6.4378E-05	5.03814E-06	4.81E-04
7.46089	4E-05	3.2704E-05	2.58565E-06	2.44E-04
8.26	0	1.31061E-05	1.05313E-06	1.08E-04
0.85	0	1.49496E-06	5.16768E-07	1.27E-06

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Nucleonica quick link

Nuclide Search **Radiation Search** Advanced Search

Radiation Search – Search Variables & Range

☒ Gamma and X-Rays Energy: 1836 +/- 1 keV
☐ Alpha 2734 +/- 1 keV
3219 +/- 1 keV

Z: Element:

Mass number:

Half-life: Seconds Seconds

Search Save to my defaults Reset

Search returned 6 results
Number of nuclides (ground + isomeric states): 2

Nuclides	Gamma and X-Rays (keV)	Emission Probability	Half-life
37 Rb 88	3218.5	0.0022	17.8 (± 1) m
39 Y 88	3218.42	7E-05	106.63 (± 2) d
39 Y 88	2734.07	0.00614	106.63 (± 2) d
37 Rb 88	2734.04	0.0011	17.8 (± 1) m
39 Y 88	1836.05	0.9932	106.63 (± 2) d
37 Rb 88	1836.02	0.224	17.8 (± 1) m

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Gamma Energies in Nucleonica: > 53,000 Energies

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Nuclear Data Retrieval

Nucleonica/JEFF-3.1 EGAF Prompt Gammas ICRP 8th Table of Isotopes

Select Database: **Nucleonica**

Nuclide Search Radiation Search Advanced Search

Radiation Search – Search Variables & Range

☒ **Gamma and X-Rays** Energy: +/- keV
☐ Alpha +/- keV
 +/- keV

Z: Element:

Mass number:

Half-life: Seconds Seconds

Search **Save to my defaults** **Reset**

Search returned 53617 results
Number of nuclides (ground + isomeric states): 1325

Nuclides	Gamma and X-Rays (keV)	Emission Probability	Half-life
13 Al 24	9943.3	0.00027	2.053 (± 4) s
15 P 28	9793.8	0.00013	270.3 (± 5) ms

13 Al 24	8015.3	0.0004	270.3 (± 5) ms
4 Be 11	7974.7	0.017400009	13.81 (± 8) s
19 K 36	7969.5	0.001271	342 (± 2) ms
15 P 28	7932.4	0.0215	270.3 (± 5) ms
13 Al 24	7930.86	0.0134	2.053 (± 4) s
19 K 36	7708.6	0.001722	342 (± 2) ms
15 P 28	7699.32	2E-05	270.3 (± 5) ms
13 Al 24	7615.17	0.00224	2.053 (± 4) s
15 P 28	7601	0.0055	270.3 (± 5) ms
15 P 28	7535.7	0.085	270.3 (± 5) ms
15 P 28	7414.92	0.0021	270.3 (± 5) ms
19 K 48	7400	0.002106	6.8 (± 2) s
15 P 28	7379.54	7.5E-05	270.3 (± 5) ms
13 Al 24	7347.83	0.00153	2.053 (± 4) s
5 B 14	7339	0.0095	12.5 (± 5) ms
19 K 48	7300.9	0.02418	6.8 (± 2) s
6 C 15	7299.2	7.400032E-05	2.449 (± 5) s
19 K 36	7177.6	0.003772	342 (± 2) ms
7 N 16	7115.15	0.0499999872	7.13 (± 2) s
13 Al 24	7069.5	0.43	2.053 (± 4) s
35 Br 88	7000.3	0.002268	16.5 (± 1) s
7 N 16	6915.5	0.00039999976	7.13 (± 2) s
15 P 28	6877.88	4.5E-05	270.3 (± 5) ms
19 K 36	6866.2	0.000902	342 (± 2) ms
15 P 28	6808.9	0.0333	270.3 (± 5) ms
4 Be 11	6790.5	0.04510011	13.81 (± 8) s
35 Br 86	6768.9	0.00096	55.0 (± 8) s
19 K 36	6729	0.00451	342 (± 2) ms
5 B 14	6726.5	0.086	12.5 (± 5) ms
35 Br 86	6722	0.000448	55.0 (± 8) s

1 2 3 4 5 6 7 8 9 10 ... >>

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Overview

Nuclide Charts

Decay and Reaction Processes on the Nuclide Chart

Karlsruhe Nuclide Chart

Gamma Emission and Isomeric Transitions

Use of Nucleonica for Gamma Emission Data

